Tennessee Science

Earth and Space Science

Earth's Place in the Universe ESS.ESS1

1. Construct an explanation regarding the rapid expansion of the universe based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. ESS.ESS1.1
2. Construct a model using astronomical distances to explain the spatial relationships and physical interactions among planetary systems, stars, multiple-star systems, star clusters, galaxies, and galactic groups in the universe. ESS.ESS1.2
3. Analyze and interpret data about the mass of a star to predict its composition, luminosity, and temperature across its life cycle, including an explanation for how and why it undergoes changes at each stage. ESS.ESS1.3
4. Communicate scientific ideas to explain the nuclear fusion process and how elements with an atomic number greater than helium have been formed in stars, supernova explosions, or exposure to cosmic rays. ESS.ESS1.4
5. Analyze and compare image data from instruments used to study deep space (e.g., visible, infrared, radio, refracting and reflecting telescopes, and spectrophotometer). Evaluate the strengths and weaknesses of the instrumentation. ESS.ESS1.5
6. Recognize how advances in deep space research instrumentation over the last 30 years have led to new understandings of Earth’s place in the universe and how these advances have benefitted society. ESS.ESS1.6
7. Analyze and interpret data to compare, contrast, and explain the characteristics of objects in the solar system including the sun, planets and their satellites, planetoids, asteroids, and comets. Characteristics include: mass, gravitational attraction, diameter, and composition. ESS.ESS1.7
8. Use mathematical or computational representations to predict motions of the various kinds of objects in our solar system, including planets, satellites, comets, and asteroids, and the influence of gravity, inertia, and collisions on these motions. ESS.ESS1.8
9. Evaluate the evidence for the role of gravitational force and heat production in theories about the origin and formation of Earth. Design a research study to confirm or refute one aspect of such evidence. ESS.ESS1.9

10 **Summarize available sources of data within the solar system which provide clues about Earth's formation. Using engineering principles, design a means to gather more data.** ESS.ESS1.10

Earth's Systems ESS.ESS2

1 **Given an environmental disaster, analyze its effect upon the geosphere, hydrosphere, atmosphere, and/or biosphere, including sphere-to-sphere interactions. Analysis should conclude with an identification of future research to improve our ability to predict such interactions.** ESS.ESS2.1

2 **Construct an argument based on evidence about how global and regional climate is impacted by interactions among the Sun's energy output, tectonic events, ocean circulation, vegetation, and human activities. The argument should include discussion of a variety of time scales from sudden (volcanic ash clouds) to intermediate (ice ages) to long-term tectonic cycles.** ESS.ESS2.2

3 **Communicate scientific and technical information to explain how evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle, and crust.** ESS.ESS2.3

4 **Analyze surface features of Earth and identify and explain the geologic processes responsible for their formation.** ESS.ESS2.4

5 **Develop a visual model to illustrate the formation and reformation of rocks over time including processes such as weathering, sedimentation, and plate movement. The model should include a comparison of the physical properties of various rock types, common rock-forming minerals, and continental rocks versus the oceanic crust.** ESS.ESS2.5

6 **Make and defend a claim based on evidence to describe the formation and on-going availability of mined resources such as phosphorous, platinum, rare minerals, rare earth elements, and/or fossil fuels.** ESS.ESS2.6

7 **Apply scientific principles regarding thermal convection and gravitational movement of dense materials to predict the outcomes of continued development and movement of lithospheric plates from their growing margins at a divergent boundary (mid-ocean ridge) to their destructive margin at a convergent boundary (subduction zone).** ESS.ESS2.7

8 **Using maps and numerical data, evaluate the claims, evidence, and reasoning that forces due to plate tectonics cause earthquake activity, volcanic eruptions, and mountain building.** ESS.ESS2.8

9 **Design a research study to examine an area of increasing seismic or volcanic activity and predict what will occur in that area over the next month, year, and decade. The description should include the instruments and measures to be used in the study and an explanation of their capabilities and limitations.** ESS.ESS2.9

10 **Construct a model which shows the interactions between processes of the hydrologic cycle and the greenhouse effect.** ESS.ESS2.10

11 **Obtain, evaluate, and communicate information about human or natural threats to Tennessee.** ESS.ESS2.11

12 **Engage in an argument from evidence to explain the degree to which the dynamics of oceanic currents could contribute to at least one aspect of climate change.** ESS.ESS2.12

13 **Use a model to predict how variations in the flow of energy through radiation, conduction, and convection into and out of Earth's systems could contribute to global atmospheric processes and climatic effects.** ESS.ESS2.13

14 **Using data, weather maps, and other scientific tools, predict weather conditions from an analysis of the movement of air masses, high and low pressure systems, and frontal boundaries.** ESS.ESS2.14

15 **Use satellite-based image datasets to compare and explain how weather and climate patterns at various latitudes, elevations, and proximities to water and ocean currents are a function of heat, evaporation, condensation, and rotation of the planet. The comparison should also include an examination of the same location across various seasons or years.** ESS.ESS2.15

16 **Design a mathematical model of Earth's energy budget showing how the electromagnetic radiation from the sun is reflected, absorbed, stored, redistributed among the atmosphere, ocean, and land systems, and reradiated back into space. The model should provide a means to predict how changes in greenhouse gases could affect Earth's temperatures.** ESS.ESS2.16

17 **Analyze the multiple sources of energy that provide power in the state of Tennessee and compare them to each other and to an alternative energy source. The analysis should include their functional components (such as infrastructure cost, on-going costs, safety, and reliability), and their social, cultural, and environmental impacts (including emissions of greenhouse gases).** ESS.ESS2.17

18 **Identify the organisms that are major drivers in the global carbon cycle and trace how greenhouse gases are continually moved through the carbon reservoirs and fluxes represented by the ocean, land, life, and atmosphere.** ESS.ESS2.18

Earth and Human Activity ESS.ESS3

1 **Identify a geographical region or small area where energy and mineral resources are scarce and evaluate competing design solutions for developing, managing, and utilizing these energy and mineral resources based on a cost-benefit analysis.** ESS.ESS3.1

2 **Obtain, evaluate, and communicate information on how natural resource availability, natural hazard occurrences, and climatic changes impact individuals and society.** ESS.ESS3.2

3 **Design, evaluate, or refine a technological solution that reduces impacts of human activities on natural systems.** ESS.ESS3.3

4 **Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.** ESS.ESS3.4